OCR
RECOGNISING ACHIEVEMENT

GCE

Applied Science

Advanced GCE

Unit **G635:** Working Waves

Mark Scheme for January 2011

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All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td></td><td>
<table>
<tr><th>device</th><th>type of wave</th><th></th></tr>
<tr><td>thermal imaging camera</td><td>infrared</td><td>✓</td></tr>
<tr><td>ultrasonic scanner</td><td>sound / ultrasound ✓</td><td></td></tr>
<tr><td>endoscope</td><td>visible / light ✓</td><td>✓</td></tr>
<tr><td>mobile phone</td><td>radio / microwave ✓</td><td>✓</td></tr>
<tr><td>CAT scanner</td><td>X-rays ✓</td><td>✓</td></tr>
<tr><td>guitar</td><td>sound ✓</td><td></td></tr>
<tr><td>radiotherapy equipment</td><td>γ-rays / gamma ✓</td><td>✓</td></tr>
</table>
All correct ticks ✓</td><td>7</td><td>NB Ticks shown in red indicate ticks which should be given by candidate not marking point indicators

ACCEPT longitudinal
ACCEPT transverse
ACCEPT transverse
ACCEPT transverse
ACCEPT longitudinal or standing NOT Vibration

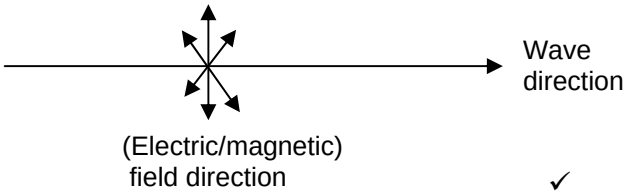
ACCEPT transverse

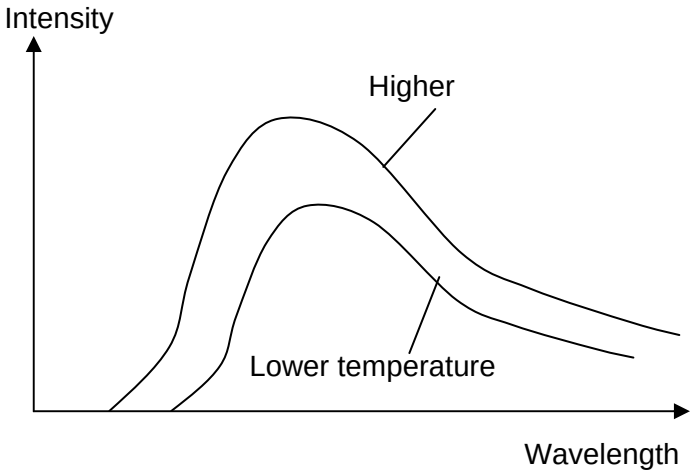
ACCEPT X-ray for radiotherapy equipment
NO ecf from type of wave. REJECT if any incorrect ticks</td></tr>
<tr><td></td><td>(b)</td><td>i.1</td><td>2.5 ✓
μm ✓</td><td>2</td><td>Must be lower case</td></tr>
<tr><td></td><td></td><td>i.2</td><td>500 ✓
m ✓</td><td>2</td><td>Must be lower case</td></tr>
<tr><td></td><td></td><td>i.3</td><td>10 ✓
ms ✓</td><td>2</td><td>or 0.01 ✓
s ✓
Unit must be consistent with order of magnitude of value but can be scored e.g. if 5 ms given
Must be lower case</td></tr>
<tr><td></td><td></td><td>ii.1</td><td>$f = \frac{1}{T}$ ✓

= 100 (Hz) ✓</td><td>2</td><td>Stated or implied. Must be in correct subsection b ii 1

NO ecf from (b) i.3 for 2nd mark</td></tr>
</table>

Question			Answer	Mark	Guidance
	(b)	ii.2	$v = f\lambda$ OR $v = \frac{\lambda}{T}$ ✓ = 50 000 (m s^{-1}) ✓	2	stated or implied. Must be in correct subsection **(b) ii.2** **ACCEPT** ecf from **(b) i.2, (b) i.3** and /or **(b) ii.1**
		iii	On Fig. 1.2 at least one cycle of a (sine) wave drawn with same wavelength displaced horizontally by any amount other than zero or whole wavelengths and with the same wavelength as the original (by eye) ✓ At least one cycle displaced horizontally by 125 ± 50 m ✓	2	Expect sine wave shape, but **accept** alternative if it is a reasonably repeating wave with same wavelength as original wave
	(c)	i	Passing through a piece of polaroid / quartz /calcite (etc) (filter) / a filter that selects only waves vibrating in one plane ✓ Reflection ✓	2	**ACCEPT** polarising filter but **REJECT** just filters or just polariser **ACCEPT** valid alternative e.g. sunlight passing through air/ atmosphere
		ii.1	Electric field at right angles to wave direction / diagram of transverse wave ✓ Magnetic field at right angles to wave direction / diagram of transverse wave ✓	2	At right angles to wave direction / transverse scores 1 mark Both at right angles to wave direction / both transverse scores both 1^{st} two marks **ALLOW** first two marks even if answer suggests both fields in the same transverse / right angles direction
		ii.2	At right angles to each other / labelled diagram showing fields at right angles to each other ✓	1	

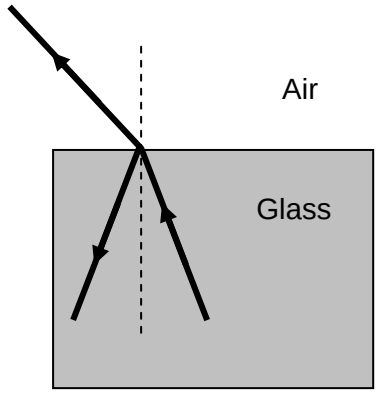
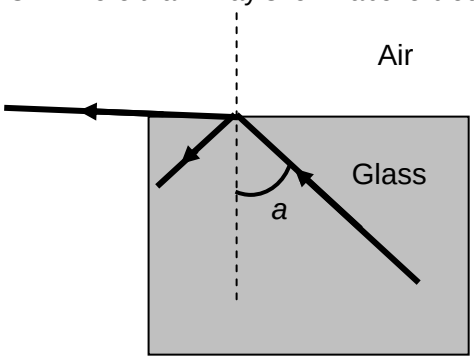
Question			Answer	Mark	Guidance
1	(c)	iii	*Any **two** from:* Each component of unpolarised wave behaves like polarised wave ✓ Unpolarised wave includes components in many/infinite number of directions / Electric/magnetic field oscillate in many/infinite number of directions ✓ Diagram e.g.  ✓	2	**ACCEPT** "description unchanged" for 1 mark **REJECT** "**travels** in many/infinite number of directions" **ACCEPT** as an alternative for either mark explanation that for each electric/magnetic field component there is always a magnetic/electric field component
			Total	**26**	

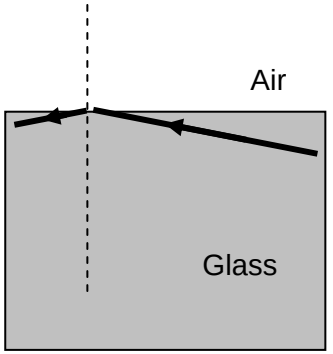
Question			Answer	Mark	Guidance
2	(a)		One which absorbs/does not reflect radiation ✓ Indication that ALL the radiation is absorbed/no radiation is reflected **or** Most efficient/best emitter of radiation ✓	2	**ACCEPT** emissivity of 1 ✓ definition of emissivity ✓
	(b)	i	Any **four** from: At least one curve with single peak not at ends ✓ Axes correctly labelled (quantity) ✓ At least two curves drawn not crossing ✓ Clear indication that peak intensity is higher at higher temperature ✓ Curve representing higher/est temperature with peak intensity not at ends and to the left of peak for lower temperature ✓	4	**ACCEPT** examples of sources at clearly different temperatures e.g. sun and light bulb e.g. (gradients not exact) 

Question			Answer	Mark	Guidance
2	(b)	ii	**[Level 1]** Candidate will demonstrate a full understanding of the variation with temperature of the appearance of a black body radiator, expressed in logical and well ordered manner and *covering points such as the following:* • Full description of colour changes as the temperature rises – <u>black</u> to red/orange and eventually <u>white</u>. ***(3 marks)*** **[Level 2]** Candidate will demonstrate an understanding of the variation with temperature of the appearance of a black body radiator in a manner that is easy to follow and *covering points such as the following:* • As the temperature rises the body will become red/orange/yellow or white. ***(2 marks)*** **[Level 3]** Candidate will demonstrate limited understanding of the variation with temperature of the appearance of a black body radiator which may not necessarily be expressed very clearly. and *covering points such as the following:* • Colour change, or increase in brightness, not necessarily clearly related to temperature ***(1 mark)***	**3**	Answer **must** relate to **appearance** to score more than 1 mark **ACCEPT** allow heating instead of temperature rises **ACCEPT** reference to change of frequency/ wavelength/ total radiation/ intensity for this mark **NB** number of ticks does not necessarily correspond to the number of marks
	(c)	i	*Any **three** from:* Thermal imaging camera distinguishes between objects at **different** temperatures ✓ Thermal imaging camera detects infrared ✓ Infrared passes through smoke ✓ Visible light absorbed by/ cannot pass through smoke ✓	**3**	AW

Question			Answer	Mark	Guidance
2	(c)	ii	*Any **one** from:* Fire / flames / scorched ground / people / animals/ fire fighters / victims / bodies /vehicles / cars / fire engines ✓	1	**ACCEPT** temperature difference
	(c)	iii	Different/ false colours ✓ **or** Shades of grey ✓	1	**ACCEPT** variation in brightness

Question			Answer	Mark	Guidance
2	(d)		**[Level 1]** Candidate will demonstrate a full understanding of another application of thermal imaging cameras expressed in logical and well-ordered manner and *covering points such as the following* • Correct link between different temperatures and either colours /different intensities /wavelengths /infra red radiation ***(4 marks)*** **[Level 2]** Candidate will demonstrate an understanding of another application of thermal imaging cameras. in a manner that is easy to follow and *covering points such as the following:* • Reference to **different** temperatures or colours • Identify object(s) (at specified parts of scene) that can be distinguished (with infra red camera) (e.g. overheated cable (and cooler background)) ***(2 – 3 marks)*** **[Level 3]** Candidate will demonstrate a limited knowledge of another application of thermal imaging cameras which may not necessarily be expressed very clearly and *covering points such as the following***:** • State application ***(1 mark)***	**4**	Any appropriate application *Applications might be e.g.:* • Electrical apparatus inspection e.g. electric circuit fault detection • Rescue e.g. detecting survivors in collapsed buildings; • Forensic • Medical imaging e.g. to reveal quantitative details of circulatory problems, arthritis and rheumatism • Military & police target detection & acquisition, night sights, weapon systems, burglar alarms • Roofing inspection (especially flat roofs) • Weather forecasting • Wide area thermal mapping **ACCEPT** heat emitted for temperatures **NB** number of ticks does not necessarily correspond to the number of marks
			Total	**18**	

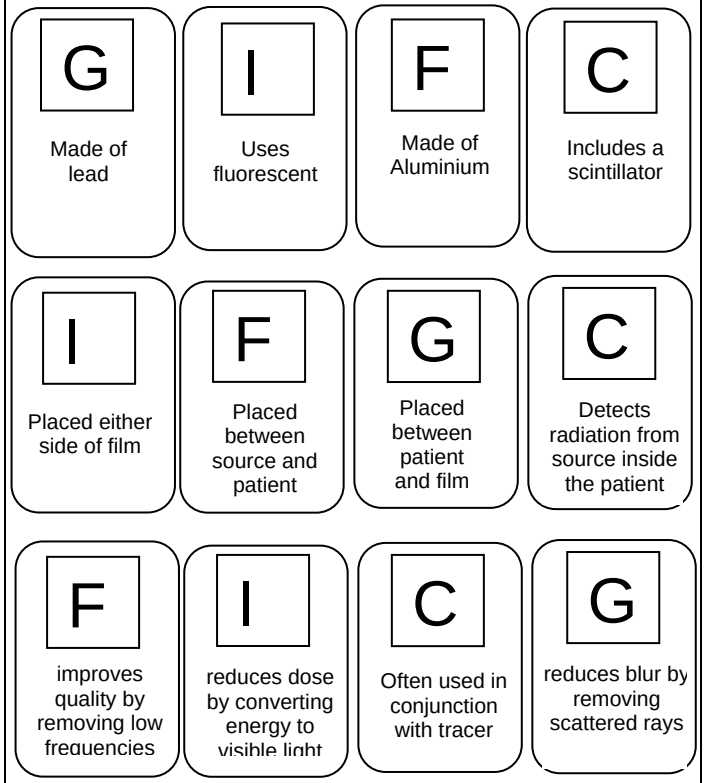
Question			Answer	Mark	Guidance
3	(a)	i	Left diagram: Refracted ray shown emerging deviated away from the normal and on the left of the normal ✓	4	**REJECT** if more than 1 ray shown above block surface 
			Centre diagram: Refracted ray shown emerging at grazing angle ✓		**REJECT** if more than 1 ray shown above block surface 
			Left **or** Centre diagram: Reflected ray shown in either (or both) of these diagrams with $r = i$ by eye ✓		(Ignore any rays drawn after this ray reaches left hand surface)

Question			Answer	Mark	Guidance
3	(a)	i	Right diagram: Reflected <u>only</u> ray shown $r = i$ by eye ✓		
		ii	No emerging /refracted light /**all** energy is retained in reflected ray or AW ✓ Angle of (incidence) (inside glass) is > critical angle/α ✓ Light travelling in medium with higher refractive index undergoes TIR when it meets a medium of lower refractive index or AW ✓ or AVP	**3**	**ACCEPT** no light escapes Accept value of 42 ± 2° in place of words “critical angle”. (Accept 48 ± 2° ONLY if medium = water is stated) The words “angle” must be clearly stated or implied (e.g. by reference to diagram). **ACCEPT** at critical angle emerging ray grazes /sin r cannot be > 1 **ACCEPT** r cannot be $>90^0$
		iii	So that light does not leak ✓	**1**	**ACCEPT** <u>all</u> the light is reflected (as it passes along the fibre)

Question			Answer	Mark	Guidance
3	(b)	i	**[Level 1]** Candidate will demonstrate full knowledge and understanding of the structure of step-index optical fibres in a logical and well ordered manner and *covering points such as **some of** the following:* Step-index fibres: • core diameter is 50 – 200 μm (accept any value in this range) covered by cladding of thickness 25 μm (accept 15 -50μm) • there is a sudden change of refractive index between core and cladding ***(5 – 6 marks)*** **[Level 2]** Candidate will demonstrate knowledge and some understanding of the structure of step-index optical fibres with in a manner that is easy to follow. and *covering points such as the following:* Step-index fibres: • refractive index of the cladding < refractive index of the core • Cladding is surrounded by (protective) sheath or AW ***(3 – 4 marks)*** **[Level 3]** Candidate will demonstrate a limited knowledge of the structure of step-index optical fibres. which may not necessarily be expressed very clearly. Candidate will indicate that step-index fibres: • made of glass/plastic • core in centre is covered by cladding ***(1 - 2 marks)***	**6**	Information contained in the diagram is acceptable but some text must be present to demonstrate the spelling punctuation and grammar requirements of the higher mark bands Note that marks are only available for description of the structure (composition, refractive index, size) and not for the way in which light behaves in the fibre **ACCEPT** (optical) density **NB** number of ticks does not necessarily correspond to the number of marks

Question			Answer	Mark	Guidance
3	(b)	ii	refractive index changes gradually between core and cladding ✓ refractive index decreases radially outwards /from centre outwards /from core to cladding ✓	2	**ACCEPT** (optical) density **REJECT** slowly **ACCEPT** (optical) density
		iii	*Any **four** from:* Less degradation/distortion of signal ✓ Fewer repeater/booster stations needed ✓ In step index fibres, the rays (at different angles to axis) travel different distances/different path lengths ✓ Explanation/diagram of why different distances for different paths ✓ Different path lengths mean different time taken/arrive out of sync. ✓ In graded index fibres paths of rays are curved ✓ In graded index fibres rays travel faster further from centre ✓ Faster because lower refractive index ✓ In graded index fibres, rays following different paths arrive at the same time✓	4	**ACCEPT** appropriate diagram showing more than one zigzag path **at different angles** **ACCEPT** appropriate diagram showing one or more curved paths
	(c)		*Any **three** from:* Dial up connections use audio/sound frequency ✓ Broadband uses much higher frequencies ✓ Greater bandwidth✓ Broadband frequency given in range 25 kHz – 1.1 MHz ✓ So data signals/1s and 0s can be closer together ✓	3	**ACCEPT** values up to 20 kHz
			Total	23	

Question			Answer	Mark	Guidance
4	(a)		Obstruction / buildings / hills ✓ Distance from base station ✓	2	**NOT** too many people trying to use system
	(b)		*Any **six (max of 4 from each of 1 and 2)** from:* 1. Transmitter signal strength would have to be very high / signal received by phone would be very weak ✓ Phone signal strength would have to be very high / signal received by mast would be very weak ✓ (Some users) too far away from tall mast /distance (from user to mast) is too great✓ Inefficient use of energy in base station ✓ Rapidly run down batteries in phone ✓ (Fears of) health hazards ✓ AVP ✓ 2. Could not have large number of people using mobile phones ✓ Limited number of frequencies available ✓ Single mast/base station/ cell means that we cannot reuse frequencies orA ✓ Taller masts unsightly/difficult to construct✓ AVP ✓	6	Or tall mast too far away (from some users) e.g Inverse square law mentioned e.g. Frequency reuse possible at non-adjacent cells
			Total	8	

Question			Answer	Mark	Guidance
5	(a)			12	
	(b)		*Any **three** appropriate points, e.g.:* Reducing the size of source used ✓ Increasing distance (from the source) ✓ Reducing time of exposure ✓ Inserting materials such as lead or concrete (between the source and the staff member) ✓ Wear a film badge /alternative monitoring ✓	3	**ACCEPT** example e.g. leave the room Exposure may be implied, e.g. by reference to patient, room etc. e.g. lead apron but not just protective clothing **IGNORE** "wear a badge", but ACCEPT "badge that will monitor (radiation) dose"
			Total	**15**	

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